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Nature of Aluminium-6063 Metal Matrix Composite with Reinforcement of Silicon Carbide by Using Stir Casting: A Review

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ABSTRACT: As a matter of fact, so many researches going on composites because of their reliabilities, flexibilities and optimization. When ever, where ever, these three concepts are very important. By Metal Matrix Composites (MMC'S) we can gain these three things. Through this paper I would like to convey the work done on AMC'S especially AL-6063 with the reinforcement of SiC. By varying the weight percentages of SiC, we finding the values of Mechanical abilities of the composite like Hardness, Tensile strength, Density, Yield strength and Impact strength. Conducting the Metallurgical tests we also known the Microstructure of the composite were investigated. Metallurgical tests like SEM (Scanning Electron Microscopy) and Transmission Electron Microscopy (TEM). We will clearly known the particles formation and distribution of the composite. Some of the Authors also tried to mix another reinforcement along with the SiC which are naturally liberated like Rice hush, Rock sand dust, Seashell powder and so on. By using these types of reinforcements we can regulate the corrosion percentage and also increase the hardness of the composition. To avoid the Clustering and non-homogenous dispersion maximum no. of authors used STIR CASTING technique to overcome this defect in composites.

KEYWORDS: AMC'S, AL-6063, SiC, MMC'S, Stir Casting, Mechanical and Metallurgical properties, Microstructure.

I. INTRODUCTION

Combining of two or more metals into single composite is a big deal to do effectively. Last few decades scientists work on it, and finally find the solution i.e.; nothing but STIR CASTING. It is one of the major processing technique in MMC'S, using among all processing methods. Through this method the reinforced particles are distributed into base metal called AMC'S sufficiently. Simultaneously it regulating the morphologies of inbuilt properties of composites depends on their chemical composites. To obtain better results, we have to do some necessary things; they are sieving the reinforcement particles according to the size, shape and orientation in the matrix. After that Pre-heating is required to removing the wetness of the materials. By these things before casting, we get better and perfect product size, shape and reducing the defects of casting like Porosities, blow-holes and inclusion etc. Being an engineer, we have to regulate the cost and maintenance and we have to improve the Mechanical and Metallurgical properties of the metal.

Stir Casting is employed in every industry due to their easy of adoption and installation. In Stir casting, base metal is melted above the melting point and after complete melting of metal, we have to add the reinforcement material slowly into the molten metal. Allow the Stirrer to rotate after adding the reinforcement, to mix both base metal and reinforced metal into a Metal Matrix Composite. After proper mixing, taken the mix into crucible for shifting into die which is in required cross-section of our need. There are so many Fabrication techniques used to prepare the AMMC'S. Among those Stir casting, Powder metallurgy, Squeeze casting, In-site process, Deposition techniques and Electroplating are widely used.

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These composite materials are divided into three matrix composites. They are:-

1. Organic Matrix Composites
2. Metal Matrix Composites and
3. Ceramic matrix Composites.

MMC'S has some good features in terms of properties like higher strength, Specific modulus, Damping capacity, Stiffness, Good wear resistance and Weight saving. In where ever, if advantages are their disadvantages are came into existences. In MMC'S the cost of fabrication is relatively high. As per my particle knowledge, SiC is cheaper than other reinforcement like Titanium Carbide, Tungsten carbide, Titanium diboride, Boron carbide which named as hard materials. Possessing significant features MMC'S are employed in Aerospace, Automobile, Defence industries, Nuclear power plant, Electronics, Bio-medical, Sporting industries etc.

Table:1 Aluminium Metal Matrix Composition:

Base Material	Reinforced Material	Combinations	Mechanical Properties			
			Tensile Strength	Hardness	Wear Rate	Density
AL-2219	B ₄ C&MOS ₂	Al2219+3%B ₄ C+3%MOS ₂ Al2219+3%B ₄ C+4%MOS ₂ Al2219+3%B ₄ C+5%MOS ₂	Decreased due to addition of MOS ₂	Increased 19.30% 21.46% 24.01%	Reduces Reduces Reduces	Increased by Increasing % of R.M
AL-6061	SiC&TiB ₂	Al6061+10%SiC+0%TiB ₂ Al6061+10%SiC+2%TiB ₂ Al6061+10%SiC+4%TiB ₂	150.1Mpa 54.8Mpa 97.9Mpa	Increased	118.11μm 94.03μm	Increased
AL356	Al ₂ O ₃	Al356+1%Al ₂ O ₃ Al356+2.5%Al ₂ O ₃ Al356+5%Al ₂ O ₃	Both Hardness and wear rate increases as the % wt of reinforcement increases			
AL-7075	SiC&B ₄ C	Al7075+10%SiC+3%B ₄ C Al7075+15%SiC+3%B ₄ C	This combination gives best performances. This posses high hardness but low toughness.			

Different Reinforcements and different combinations were used in metal matrix of Aluminium series was illustrated as above. After varying different wt% calculated the mechanical properties like tensile strength, hardness, wear rate and density.

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The chemical composition of Aluminium 6063 showed as below:

Table:2 Chemical Composition of Al-6063:

Constituent	Al	Cr	Cu	Fe	Mg	Mn	Si	Ti	Zn
% wt	97.5	0.1	0.1	0.35	0.9	0.1	0.6	0.1	0.1

The above table gives the brief view about the wt% of different chemicals consisted in Al-6063. Along the Al there are eight more chemicals present in Al-6063. A major composition is Al having 97.5% and remains chemical shares different weight ratio in whole composition.

Applications of Aluminium:

They are so many areas the Aluminium metal plays a good and reliable role. Some of the areas like Electrical conductors, Transport, Packaging, Building and Architecture, Miscellaneous applications, High pressure gas cylinders, Machined components, Ladders and access equipments, Sporting equipments, Roads barriers and signs, Domestic and office furniture's and Lithographic plates.

Silicon Carbide SiC:

Silicon carbide also called as carborundum, and it is a semi-conductor containing silicon and carbon. It is available in nature as the extremely rare mineral moissanite. Synthetic SiC powder has been mass-production since 1893 for use as an abrasive.

The chemical composition of Sic as shown below:

Table:3 chemical composition of SiC:

Constituent	SiC	Si	SiO ₂	Fe	Al	C
% wt	98.5	0.3	0.5	0.08	0.1	0.3

The above table shows the percentage of contents present in SiC Along with the SiC there are five more chemicals. The major proportion is SiC having 98.5 and the remaining proportion is shared by the remaining contents Si, SiO₂, Fe, Al and C.

Properties of Silicon Carbide:

The following are the different properties of silicon carbide which posses in it. They are:-

- (a) Low density
- (b) High strength
- (c) Low thermal expansion
- (d) High thermal conductivity
- (e) High hardness
- (f) High elastic modulus
- (g) Excellent thermal shock resistance.
- (h) Superior chemical inertness.

Uses of SiC:

Being the hardest material, it is used in different areas for increasing the life of the product. Abrasive and cutting tools, Structural materials, Automobile parts, Foundry crucibles, Electrical systems, Electronic circuits elements, Power electronic devices, LED'S, Astronomy, Thin filament pyrometer, Heating elements, Nuclear fuel particles and Cladding, Jewellery, Steel production, Quantum physics.

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II. OBJECTIVE

The main motto of this observation is how the mechanical properties were varying by changing the percentage of reinforcement in AMC'S. And also knowing the different techniques was used to fabricate MMC'S, as a way what is the importance's of Composites in today's and future world.

III. RELATED WORK

Abba Green: In this experiment, the authors were prepared the MMC'S by Stir casting. In the process of doing the experiment he used Al liquid, Electric motor, SiC particles, Insulated boards, Blades and crucibles. To the Al liquid, different weight % of SiC is added and the molten melt is heated at 680° in order to attain homogenous composition. In his research he did a tensile test, Hardness test, Microstructure test at room temperatures.

For Tensile test he utilized UTM, from that machine he obtained the values and he concluded that, Ultimate tensile strength and Yield strength was increased by increasing the weight percentage of SiC. Simultaneously the percentage of Elongation of composite also decreases gradually. In the same way hardness also increased. The micro structure of the composite tells the uniform distribution of reinforcement in matrix metal, due to that the Mechanical properties of composite increased.

Raj Kumar et al: Overview of this experiment, Authors adopted economical process i.e.; Vortex method (or) Stir casting process. They pre-heated the SiC of having mesh size in between 220-400 constituent part into the vertex of melted alloy which is produced by rotating impeller. Micro structural in homogeneity can cause addition of constituent part and sedimentation when it melts (or) solidifies. In Microstructure testing, the fabricated MMC'S is polished in a fine way, for these they use rubbing the sample of emery paper(100-200microns) and the velvet cloth with help of polishing machine and the surface cleaned with killers etching regent.

They observed the fine grain structure through Optical microstructure tester (range X50-X1500). Through (UTM) they conducted Tensile strength test and observed that increasing by increasing wt% of reinforcement. By using Micro Vickers Hardness testing Machine, they observe the hardness of the composition and state the hardness of composite is increased.

Shevi Sharma et al: In this experimental work, they utilized Stir casting technique for processing of metal matrix composites. They choose the parts of the casting according to the properties and qualities. The liquid metallurgy route (Stir Casting Technique) had been adopted to prepare the cast composites, they taken SiC power particles size of 1000 mesh and also introduced into the Vortex of the molten alloy for efficient degassing to overcome the casting defects. They Stir's the molten metal up to 1-12 minutes by using Steel Impeller. Then they maintained speed at 650 rpm. Pour the molten metal in mild steel moulds at the temperature of 900°. They added the SiC in matrix alloy was 10% by wt. The Tensile property of the composite is increased by increasing wt% of SiC. From their results we observed that % of Elongation decreases from 22-9.82. Hardness of the composites appeared in upper layer of melted matrix in crucible comparison.

IV. LITERATURE REVIEW

Hari Dass et al: Observed that, they used Stir Casting as a technique, Al-6063 as base metal and SiC and Rice husk ash as reinforcements on note of experimental process. They had taken 650grms of pure Al and desired amount of SiC and rice husk ash in powder form. The reinforcements are pre-heated at 300° for 1hr to remove the moisture content in it. The matrix material is melted in Electric furnace, which is Stir casting machine. The melted temperature is must be maintained up to 720° and the melt is stirred with the help of mild steel stirrer. The melt is stirred at a speed of 200rpm in the time duration of 3-5mins. Then the reinforcements are added to the melt mixture. The molten metal which is comes from furnace is poured into a metallic mould at temperature of 680°. With the help of the fabricated

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mould specimens, have done a corrosion test. From that they concluded that, the corrosion rate of the specimens is gradually decreased by varying wt% of reinforcements.

Sandeep kansari et al: In detailed view, they used Stir Casting technique and melted Aluminium as base metal. They melted Aluminium alloy in a muffle furnace at 800°C in the span of 3-4hrs. Then the reinforcements Silicon Carbide particles and Graphite particles were pre-heated at 1000°C and 900°C respectively up to 3hrs to aloe surface oxidized. Set the furnace temperature at 750°C to melt the Aluminium until it comes to liquid state. After melting of Aluminium alloy add the reinforcement particles through Vortex. After that set the final mixing processes at a temperature 700±10°C of furnace. Then the molten metal poured into a mould for the purpose of getting a desired shape. Through this, they concluded hardness and tensile strength are increased by increasing the wt% of Silicon carbide as well as Graphite particles. They find out the distribution of SiC and Graphite into a base metal is uniform. Due to the uniform distribution of reinforcement the strength of composite is increased.

Hashim et al: In stir Casting they observed four technical difficulties: difficulties such as achieving a uniform distribution of the reinforcement materials; wet ability between the base material and the reinforcement; porosity in the cast metal matrix composites; and chemical reactions between the reinforcement materials and the matrix alloy. In order to overcome these difficulties need to achieve a MMC'S with a broad range of Mechanical properties. They have also points the important processes variables that affects the Mechanical properties of MMC'S. Different prospective like holding temperatures, stirring speed, size of the impeller and the position of the impeller in the melt are to be taken into account in the production of cast metal matrix composites.

Rama rao et al: In this experiment, they manufactured aluminium boron carbide composites by Stir Casting method by adding different wt% of the reinforcement. The following were the variations of weights 2.5, 5, 7.5%. X-ray diffraction method is used for phase identification of boron carbide SEM (scanning electron microscope) is used for microstructure analysis. Mechanical properties like Toughness, Hardness and Compression is increased with the amount of composite decreased but Hardness is increased. The Strength is increased with the increase of weight percentage of boron carbide on composites.

Jayaseelan et al: In this, author's compared to different methods of extrusion characteristics of Al-SiC fabrication processing. One is Liquid state metallurgy and another one is Powder metallurgy. By using Stir Casting material gives fine microstructure and high hardness while compared to Powder metallurgy and they also sort that high strength.

Nahar et al: Studied that fabricate the Al-SiC by utilizing Liquid Stir Casting and Semi-Solid Stir casting methods. In this, have to maintain the stirrer speed at 200-500rpm. Silicon Carbide particles having 30µm were used by 10% volume. The main objective of this is, to fabricate uniformly distributed homogeneous composites and also observes faster rate of solidification.

V. CONCLUSION

In this Literature review AMC'S is manufactured by using liquid state metallurgy called stir casting technique. The varying of SiC content in the composition results the microstructure analyses and mechanical properties like hardness, tensile strength, yield strength etc were studied. The defect of gas struck due to vortex creation may be overcome by introducing the particulates by means of an injection gun with an inert gas carrying it. The SiC wt% is uniformly distribution is partially homogenous with the increasing of SiC composition in the composite. There have differences in the geometry of the stirrer and feeding mechanism to get homogenised material. The porosity also increases by the increasing the percentage of reinforcement where as the density of composites decreased. The density of the hybrid of composites decreased as well as ductility by addition of SiC. Having reliable properties in Al-SiC composites, they have been employed in different areas like Aerospace, Automobiles industries. Stir casted equipments are used in precise microprocessor based electronics control panels for control of Stirrers rpm, Vibration, timing etc.

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